section 11

CD V-720-1

specifications:

- Ranges: 0-5, 0-50, 0-500 r/hr
- Sensing Element: Ionization Chamber
- Accuracy: ±15% of true dose rate from cobalt 60 gamma radiation
- Batteries: One 1-1/2 volt NEDA 13
  Two 22-1/2 volt NEDA 215
- Dimensions: approx. 9-1/2" long x 4-3/4" wide x 7-1/4" high including handle
- Weight: approx. 4-1/2 lbs. including batteries

table of contents

GENERAL DESCRIPTION

Introduction	11-1
Meter and Controls	11-1
Adjustments and Readings	11-2
Batteries	11-3
Electronic Circuitry	11-6

SERVICING

Precautions	11-7
Disassembly Instructions	11-8
Preventive Maintenance	11-9
Repairs	11-10
Trouble Shooting	11-11

PARTS LIST

Electrical Components	11-23
Mechanical Components	11-26

list of illustrations

Figure 11-1	Meter Face	11-3
Figure 11-2	Opening of Case	11-4
Figure 11-3	Battery Compartment Modification	11-4
Figure 11-4	Battery Compartment	11-5
Figure 11-5	Rear View of 9-Pin Socket Showing Location of Test Points	11-19
Figure 11-6	High Impedance Section Showing Location of Test Points	11-19
Figure 11-7	Schematic Circuit Diagram	11-20
Figure 11-8	Schematic Circuit Diagram Showing Switch Wafers and Socket Connections	11-21
Table 11-1	Switch Positions vs Meter Readings	11-2
Table 11-2	Test Point Chart	11-18

GENERAL DESCRIPTION

Introduction

The Chatham CD V-720 model 1 is a portable ionization chamber instrument designed for the detection of high levels of beta and gamma radiation. The ionization chamber is located inside the case in the lower front portion of the instrument. The entire instrument and its accessories include an indicating meter, ionization chamber, and carrying strap. The bottom of the instrument case contains a sliding beta shield to permit discrimination against beta particles if desired.

Meter and Controls

The CD V-720-1 uses a ruggedized, sealed meter to meet the instrument requirements for water-tightness, shock, and vibration resistance. Two controls are provided. One control is a range selector switch which turns the instrument on, checks its operation, and selects the desired sensing range. The other is a zero control which is used to adjust the instrument to assure proper reading. Zeroing compensates for temperature variations and battery aging.

Adjustments and Readings

Zero Adjust

With the sliding beta shutter on the case bottom closed, turn the range switch to the ZERO position. After allowing one minute for the instrument to warm up, rotate the ZERO control as necessary to zero the meter. If the meter cannot be zeroed, refer to the Trouble Shooting Guide for this instrument.

Circuit Check

Turn the range switch from the ZERO position to the CHECK position. The range switch must be held against the stop in this position since the switch is spring-loaded to return to OFF. The meter should read in or above the red outlined section labeled CIRCUIT CHECK. Weak or dead batteries are often the cause of inability to zero or circuit check the instrument. Refer to the Trouble Shooting Guide for corrective measures if a low reading is obtained.

The zeroing and circuit check operations may be performed at any time whether the instrument is in a radiation field or not. However, the instrument must be zeroed before making the circuit check.

Sensing Ranges

The radiation sensing ranges are activated by turning the range switch to X100, X10, or X1. The sensing ranges can be checked only for erratic or upscale readings unless a radioactive source is available. In the absence of radiation, the meter should return to within 3 minor divisions of zero after allowing a few seconds for transient currents to dissipate.

Table 11-1 lists switch positions and the corresponding meter readings. Figure 11-1 shows the meter face. Readings should not be taken with the pointer indicating in the lower 10% of the scale. Turn to the next most sensitive range until the pointer indicates in the upper 90% of the scale.

Switch Position	R/hr
X1	0-5
X10	0-50
X100	0-500

Table 11-1. Switch Positions vs Meter Readings

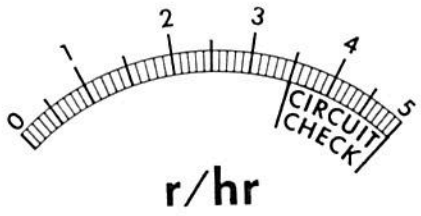


Figure 11-1. Meter Face

The sliding beta shield on the bottom of the instrument case assists in determining the type of radiation being detected. When the shutter is closed over the beta window of the ion chamber, the instrument is sensitive to gamma radiation only. With the shutter open, the instrument detects the presence of both beta and gamma radiation.

Batteries

The CD V-720 model 1 is powered by one 1-1/2 volt "D" size battery and two 22-1/2 volt "B" batteries. The batteries will operate the instrument continuously for over 150 hours and much longer on an intermittent basis. Refer to Appendix A for acceptable types and makes of batteries.

Installation

After making sure the instrument is turned off, open the instrument by turning the thumb screw in the center of the instrument in a counterclockwise direction. Slowly raise the instrument top until the chamber cable is accessible as shown in figure 11-2. Disconnect the cable by gently pulling on the aluminum shield of the cable connector.

A piece of electrical tape must be installed inside the lid of each instrument to prevent the 1-1/2 volt battery from shorting to the case. This field modification must be performed on each instrument prior to the installation of the batteries to insure reliable operation of the instrument. See figure 11-3 for placement of the tape.

When installing batteries, never allow any of the terminals to touch ground or the electrometer tube may be burned out.

1. Close the snap fasteners on each of the battery straps.

2. Install the 22-1/2 volt batteries by inserting the + end of the battery into the battery strap as shown in figure 11-4. Press the negative end of the battery into the strap until the contact pin slides into the hole on the negative battery contact. Both 22-1/2 volt batteries are installed in the same manner.
3. Install the 1-1/2 volt battery in the larger strap by inserting the + terminal of the battery into the positive contact of the strap. Press the negative end of the battery into the strap until the negative contact slides into the recess in the (-) end of the battery. The 1-1/2 volt battery strap will also make sufficient contact with batteries that do not have the recess in the (-) terminal.

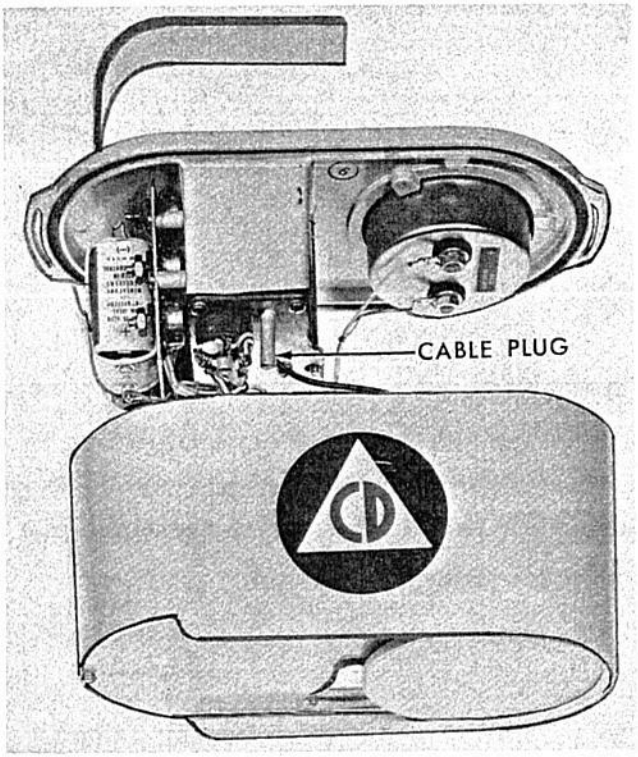


Figure 11-2. Opening of Case

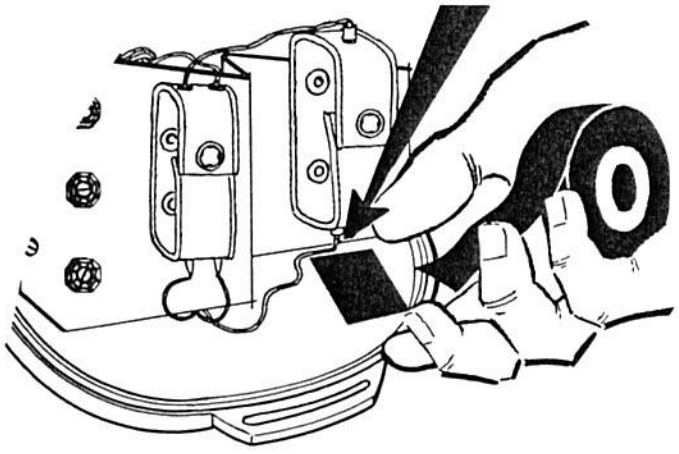


Figure 11-3. Battery Compartment Modification

Reconnect the ionization chamber cable as the instrument is placed into the case bottom. The instrument will fit in the case in only one way — the ion chamber and meter at the same end. Tighten the thumb screw in the center of the instrument case.

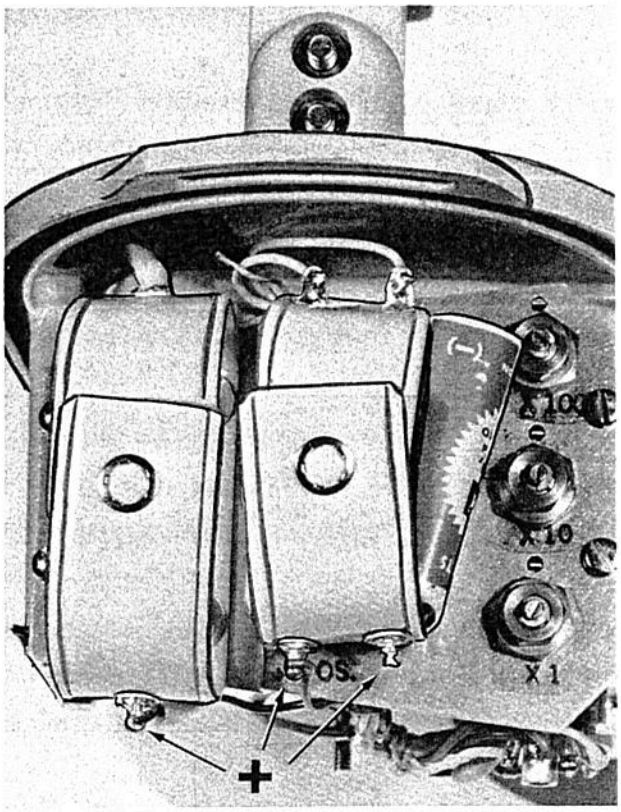


Figure 11-4. Battery Compartment

Replacement

The batteries should always be checked before making further instrument repairs or adjustments. The batteries may be checked with a voltmeter while installed in the instrument. With the range switch in the ZERO position, the 1-1/2 volt battery should read at least 1.25 volts and the 22-1/2 volt batteries should read 19.5 volts or higher. The batteries may also be removed and checked with a battery tester.

Good batteries are required since a direct relationship exists between battery voltage and instrument response to radiation. Instruments with very weak batteries may give errors in radiation response even though satisfactory circuit check and zero adjustment may be obtained.

Electronic Circuitry

All electrical components which make up the circuitry are mounted inside a water-tight compartment using conventional wiring techniques. Wiring harnesses and cables are used to connect the various sections of the instrument. The circuitry serves to measure the minute current from the ionization chamber which indicates the presence of ionizing radiation. The high impedance components are housed in a light-tight enclosure for protection and shielding.

The current from the ionization chamber is amplified by an electrometer tube amplifier circuit utilizing a 5886 or VX-86 electrometer tube. With the range switch in the ZERO position, the high megohm resistor is removed from the grid circuit so that no signal voltage can be developed as a result of any ionization chamber current. The plate current is balanced against the bucking current, and the resultant current through the meter is zero. The bucking current is obtained from the filament battery and is adjusted by means of the ZERO potentiometer.

When the range switch is placed in one of the sensing ranges, the high megohm resistor is reinserted in the grid circuit. Current from the ionization chamber produces a positive signal voltage across this resistor which results in an increase in plate current. The resultant current through the meter is no longer zero, and the meter therefore measures the increase in plate current. The range switch changes high megohm resistor values to keep the voltage applied to the electrometer tube grid within the proper operating range.

SERVICING

Precautions

High Impedance Circuitry

The high megohm resistors, electrometer tube, ceramic switch wafer, ionization chamber terminal and cable, and the teflon feed-thru constitute the high impedance circuitry of the CD V-720-1. Any accumulation of dirt or grease on these parts will render the instrument inoperable. These parts must not be handled except in accordance with instructions in Section 1 of this Manual.

Electrometer Tube

When checking for a possible open filament of the electrometer tube, use an ohmmeter which has an output current of less than 10 ma when used to measure resistances of about 100 ohms. Current in excess of 10 ma may destroy the filament. No damage will result from use of the ohmmeters described in Appendix B.

Replacing the electrometer tube requires special procedures to avoid damaging the glass feed-thru. Follow the instructions for electrometer tube replacement on page 11-10.

Ionization Chamber

The beta window of the chamber is a thin stainless steel disc. If the window should be punctured, the seal of the chamber is destroyed and the readings are no longer independent of altitude, temperature, and humidity. Keep the beta shield closed when servicing the instrument.

Battery Installation

Do not allow the battery contacts or terminals to touch the instrument case while installing or the electrometer tube filament may be burned out. Be sure the modification shown on pages 11-3 and 11-4 has been performed before installing batteries.

Glass Feed-Thru

The pins on the glass feed-thru break easily. Use caution when soldering to these pins, or when removing the 9-pin socket.

Disassembly Instructions

1. Open the instrument by turning the thumb screw in the center of the instrument top. Slowly raise the top from the case bottom until the chamber cable is accessible. Disconnect the cable by gently pulling on the aluminum shield of the cable connector. (See figure 11-2)
2. Remove the 9-pin socket from the glass insulated plug on the circuit capsule.
3. Remove the knobs, rubber boot, locknuts, and lockwashers from the range switch and zero potentiometer.
4. Remove the 5 screws holding the capsule assembly to the top cover enclosure.
5. Unsolder the two meter leads.
6. Push down gently on the shafts of the switch and potentiometer and guide the entire sub-assembly out of the enclosure. The capsule itself is not rigidly attached to the range switch and it is therefore possible for the capsule to separate from the switch shaft while this is being done. The switch shaft and studs can be re-inserted into the capsule after the assembly has been removed from the enclosure. A small amount of

pressure will then be required to hold them together.

7. For ease in trouble shooting, reconnect the 9-pin socket to the feed-thru connector and connect one of the switch studs to the battery mounting bracket for an electrical ground. Reconnect the meter leads.
8. Replace the control knobs for switching and adjusting the zero. The instrument is now operable. The ionization chamber may be attached by reconnecting the ion chamber cable and using a test lead to ground the chamber to the circuitry.

Preventive Maintenance

It is recommended that preventive maintenance procedures be carried out once a month when the instrument is in use and once every six months when the instrument is in storage.

1. Remove the batteries, clean the battery contacts and battery terminals, and remove any corrosion present.
2. Reinstall the batteries making certain that all batteries make good contact and exceed the minimum operating voltage.
3. Perform the Zero and Circuit Check operations.
4. If the instrument is to be shipped or stored, remove the batteries and set the range switch to one of the sensing ranges. This will shunt the meter and minimize damage from movement of the pointer during shipment or storage.

Do not use cleaning solvents for cleaning any plastic parts. Clean the case with soap and water. If the batteries have leaked, soak out the residue by pouring 1/4" of water into the case bottom. Do not allow the water level to reach the ion chamber connection. Battery spillage can be loosened in a short time and be rinsed out. Dry the case thoroughly before reassembling. HUMI-SORB desiccant or its equivalent should be packed in the case bottom of the instrument upon receipt at warehouses and upon completion of servicing or periodic maintenance. Be sure that the modification shown on pages 11-3 and 11-4 has been performed.

Repairs

Electrometer Tube Replacement

1. After disassembling the instrument, unsolder the screen and plate leads of the electrometer tube from the solder connectors on the pink and yellow wires from the center switch wafer.
2. Unsolder the red and blue leads which extend up through the capsule cover and are soldered to the center switch wafer. The switch assembly can now be moved aside for better access to the electrometer tube.
3. Remove the four screws holding the capsule cover to the capsule, and slide the cover off slowly to prevent damaging the leads to the assembly.
4. Unsolder the grid lead from the Teflon feed-thru located inside the capsule.
5. Unsolder the butt connectors from pins 8 and 9 of the glass feed-thru to provide access to the filament leads.
6. Unsolder the two filament leads from the glass feed-thru. The electrometer tube should now be completely free.
7. Install the insulating sleeves and cut the leads of the new tube to the same length as those on the old one.
8. Wrap the ends of the filament leads around a small pin which is approximately the same diameter as the pins on the glass feed-thru. Do not attempt to wrap the leads around the feed-thru pins since they break easily.
9. Slide the filament leads onto the appropriate pins on the glass feed-thru, and reverse the above procedure to complete the installation.
10. Before reassembling the instrument, bake the high impedance circuitry for a few minutes at $150^{O}F$ or less to drive off moisture.

Battery Holder Replacement

Remove the calibration controls from the plate holding the battery straps and the calibration controls by removing the two nuts on each control. Do not alter the adjusting screws under any circumstances since this will destroy the calibration of the instrument. Install the new plate with the battery straps already mounted and reinstall the calibration controls.

Trouble Shooting

The information in this section is presented as an aid to the service technician in determining the causes of specific instrument faults. The Trouble Shooting Guide lists the most probable causes of instrument failure together with suggestions for corrective action. This should be consulted and followed after the following preliminary steps have been taken:

1. Check all batteries. Make sure they exceed the minimum voltage for proper operation of the instrument.
2. Disassemble the instrument through step 8 of the Disassembly Instructions.
3. Check the circuitry for broken or frayed wires, poor solder connections, and broken components.

Table 11-2, Test Point Chart, and figures 11-5 and 11-6 which show the location of the Test Points, eliminate the need for circuit tracing when making voltage and resistance measurements. The Test Points are referred to in the NOTES column of the Trouble Shooting Guide, and are also found on both schematic circuit diagrams.

TROUBLE SHOOTING GUIDE

RANGE SWITCH POSITION	SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION	NOTES
ZERO	Dead	Poor connection to battery	Repair connection	Check voltage at G
		Meter defective	Repair or replace meter	
		Open contact on S1-1 FRONT	Repair switch	Check continuity at C - ▲
	Downscale	Battery inserted backwards	Reverse battery	
		Poor contact to batteries	Repair connections	Check voltage at J, K
		V1 filament open	Replace V1	Check resistance at G - ▲
		Open contact on S1-1 FRONT	Repair switch	Check resistance at J - ▲
		Open contact on S1-1 REAR	Repair switch	Check continuity at A - M
		Wires at base of V1 shorted	Reposition wires	
		Pin on switch or R7 shorted to ground	Reposition pin or wires	

RANGE SWITCH POSITION	SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION	NOTES
ZERO (cont'd)	Upscale	Battery inserted backwards	Reverse battery	
		R7 defective	Repair or replace R7	
		V1 defective	Replace V1	Check V1 for shorts
	Erratic	Meter defective	Repair or replace meter	
		Open contact on S1-1 FRONT	Repair switch	Check resistance at J - ▲ Check continuity at C - ▲
		Open contact on S1-1 REAR	Repair switch	Check continuity at M - A
		Open contact on S1-3 FRONT	Repair switch	Check continuity at H - M
		R7 defective	Repair or replace R7	
		V1 defective	Replace V1	
CIRCUIT CHECK	Below Red Area	Batteries low or making poor contact	Replace batteries or repair contact	
		Open contact on S1-3 FRONT	Repair switch	Check continuity at H - L
		R1 defective (less than 56K)	Replace R1	
		V1 transconductance low	Replace V1	

Radiation Sensing Ranges	Upscale on one or more ranges, but greatest effect on X1 range	Moisture contaminating high impedance components	Dry out with heat (150°F or less) or desiccant	
		Chamber defective	Repair or replace chamber	Remove chamber cable and check instrument again
		V1 defective	Replace V1	Check V1 for grid current
	Pegs upscale on all ranges	V1 defective	Replace V1	Check V1 for shorts
	No response to radiation on all ranges	Chamber defective	Repair or replace chamber	
		Chamber cable defective	Replace cable	
		V1 defective	Replace V1	Check V1 for transconductance
	Low response to radiation on all ranges	Chamber defective	Repair or replace chamber	
		V1 defective	Replace V1	Check V1 for transconductance
	No response to radiation on only one range	Calibration control turned fully counterclockwise	Recalibrate on particular range	
		High megohm resistor dirty or defective	Clean or replace high megohm resistor	Check resistances at H - M
		S1-3 FRONT defective	Repair switch	Check resistances at H - M

RANGE SWITCH POSITION	SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION	NOTES
Radiation Sensing Ranges (cont'd)	Low response to radiation on only one range	Calibration disturbed	Recalibrate on particular range	
		High megohm resistor dirty or defective	Clean or replace high megohm resistor	Check resistances at H - M
	Erratic response to radiation	Dirt on ceramic switch wafer	Clean switch	
		Chamber cable defective	Repair cable	
		Chamber defective	Replace chamber	
		Meter defective	Repair or replace meter	
		S1-1 FRONT defective	Repair switch	Check resistance at J - ▲ Check continuity at C - ▲
		S1-1 REAR defective	Repair switch	Check continuity at D - ▲ E - ▲ F - ▲ M - A
		S1-3 FRONT defective	Repair switch	Check resistances at H - M
		V1 defective	Replace V1	

CD

RESISTANCE CHART

Remove batteries before checking resistances. Values ±10% except as noted.

Component	Points	Range Switch Position	Resistance (ohms)
S1-1 FRONT	C - ▲	All except OFF	0
	J - ▲	All except OFF	68K
S1-1 REAR	A - M	All except OFF	0
	B - ▲	OFF	0
	D - ▲	X100	0
	E - ▲	X10	0
	F - ▲	X1	0
S1-3 FRONT	H - L	CIRCUIT CHECK	0
	H - M	ZERO	0
	H - M	X100	1.5×10^{9}
	H - M	X10	1.5×10^{10}
	H - M	X1	1.5×10^{11}
V1 filament	G - ▲	Any	110 ±20%

VOLTAGE CHART

Voltages measured with respect to point ▲ with instrument correctly zeroed on ZERO range. Use a 20,000 ohms per volt meter. All values ±20%.

Point	Voltage	Voltmeter Range
K	16	50
J	10	50
G	1.5	2.5

Table 11-2. Test Point Chart

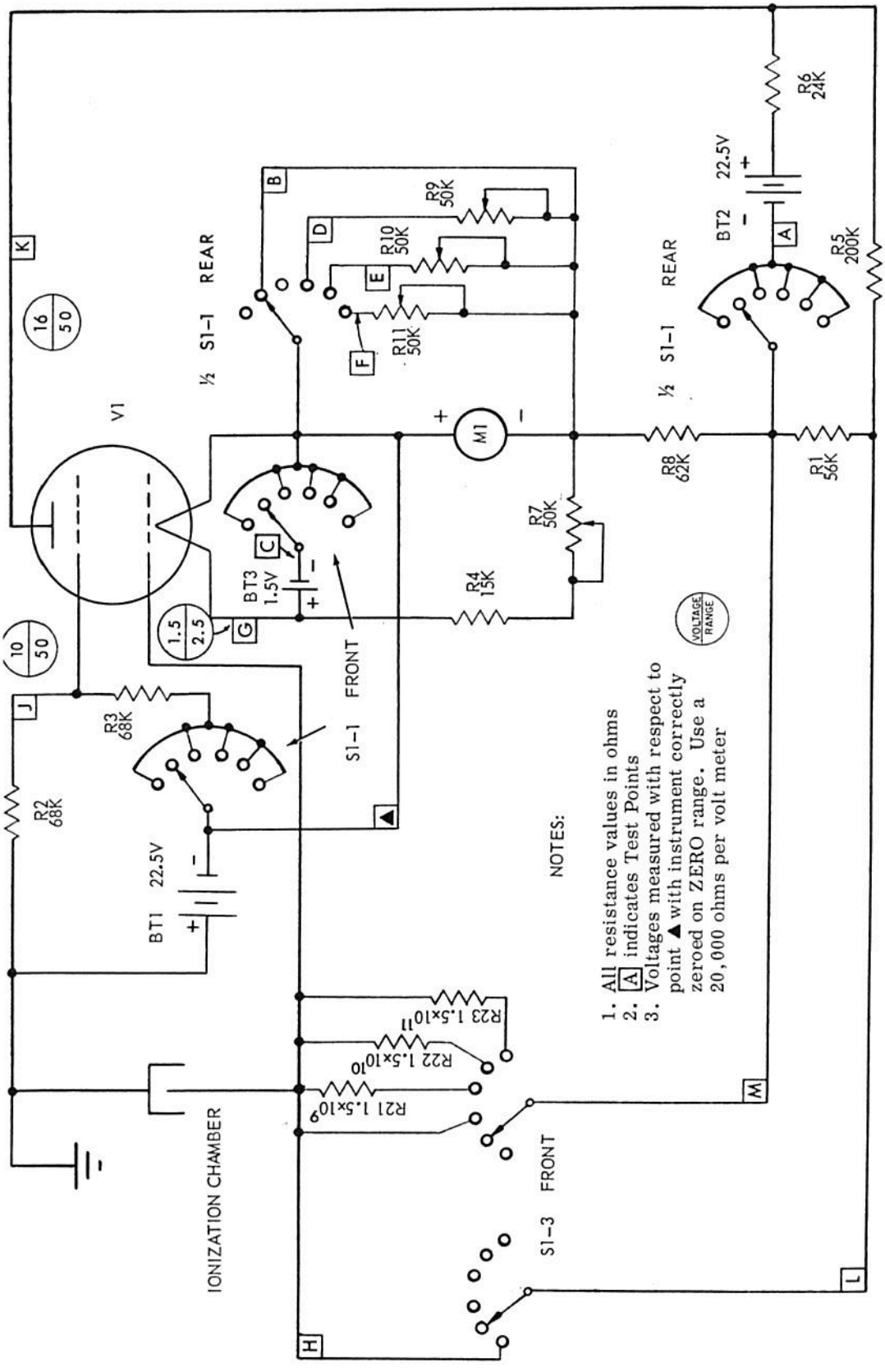


Figure 11-7. Schematic Circuit Diagram

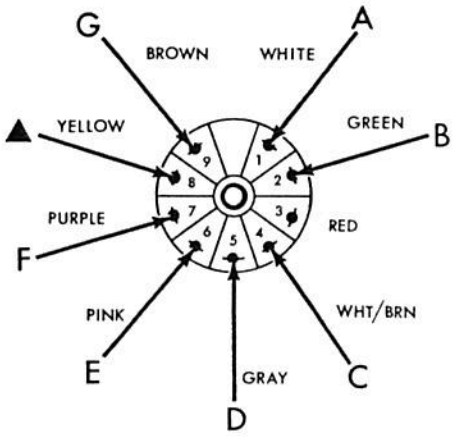


Figure 11-5. Rear View of 9-Pin Socket
Showing Location of Test Points

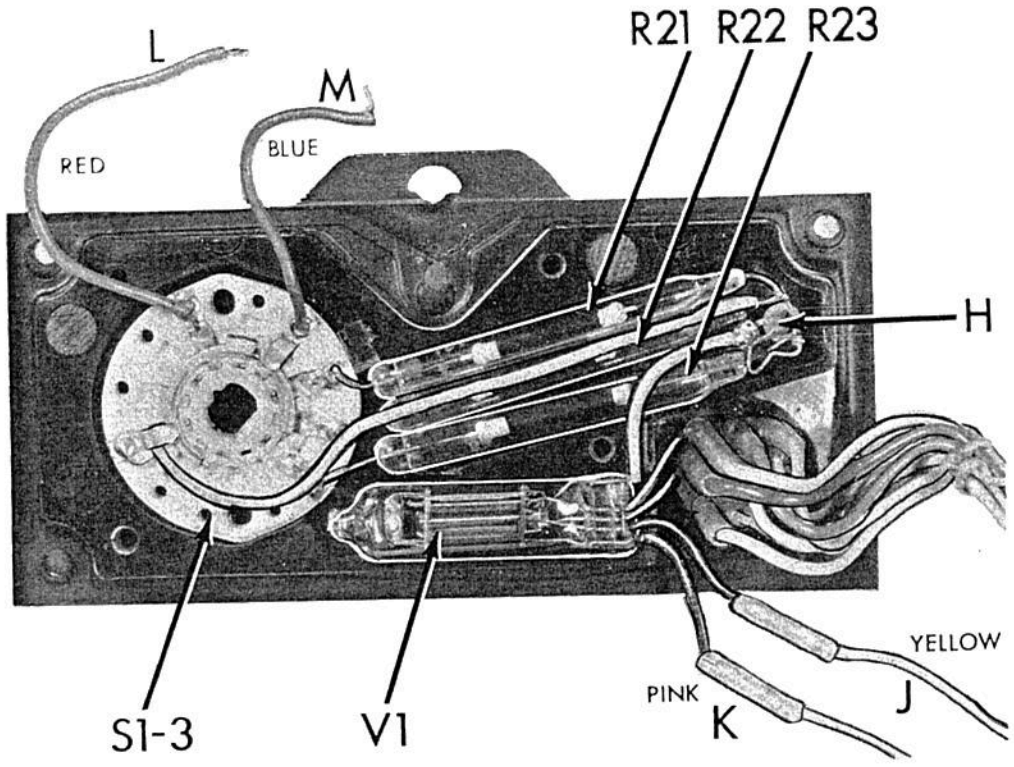


Figure 11-6. High Impedance Section
Showing Location of Test Points

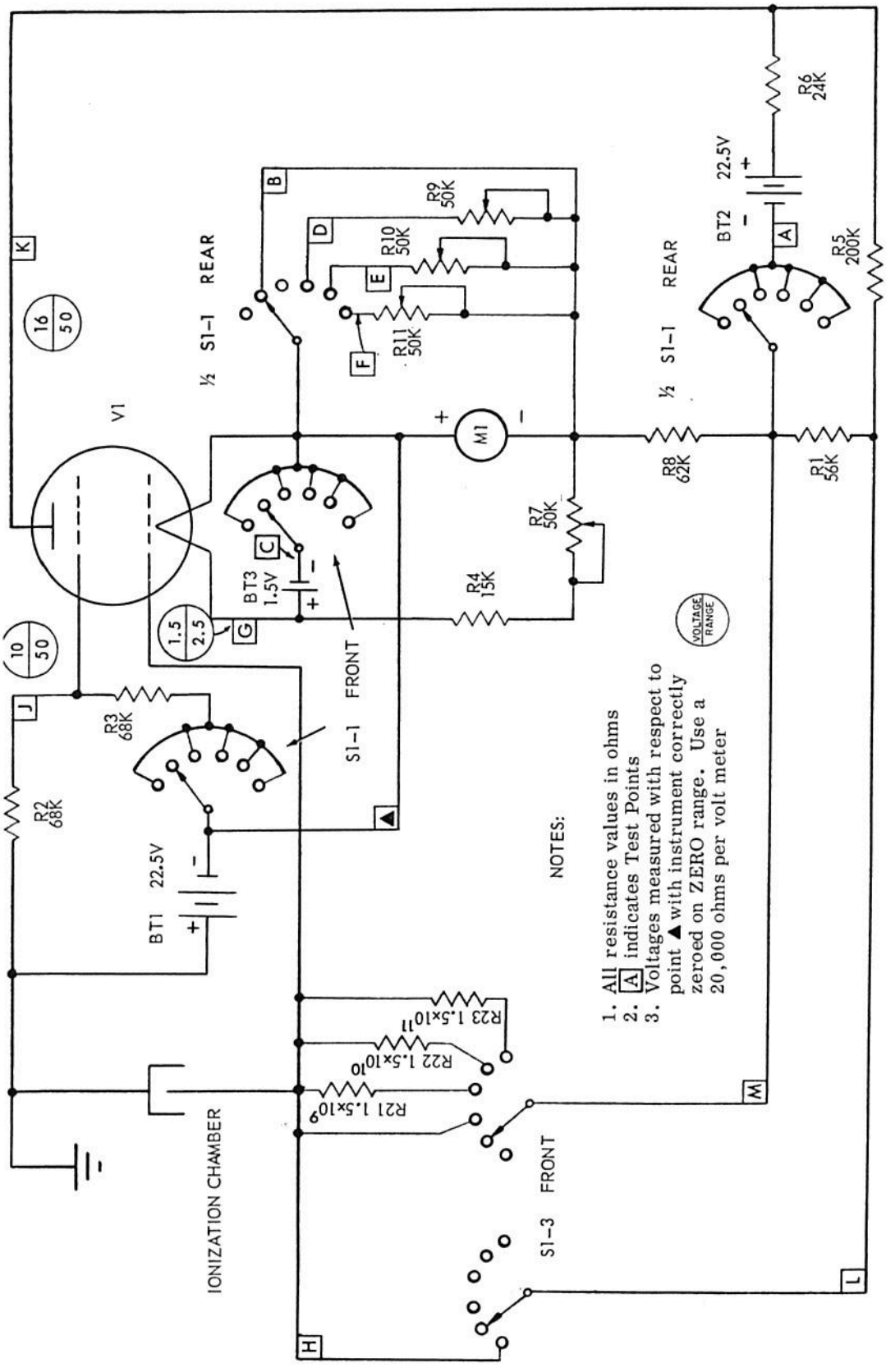
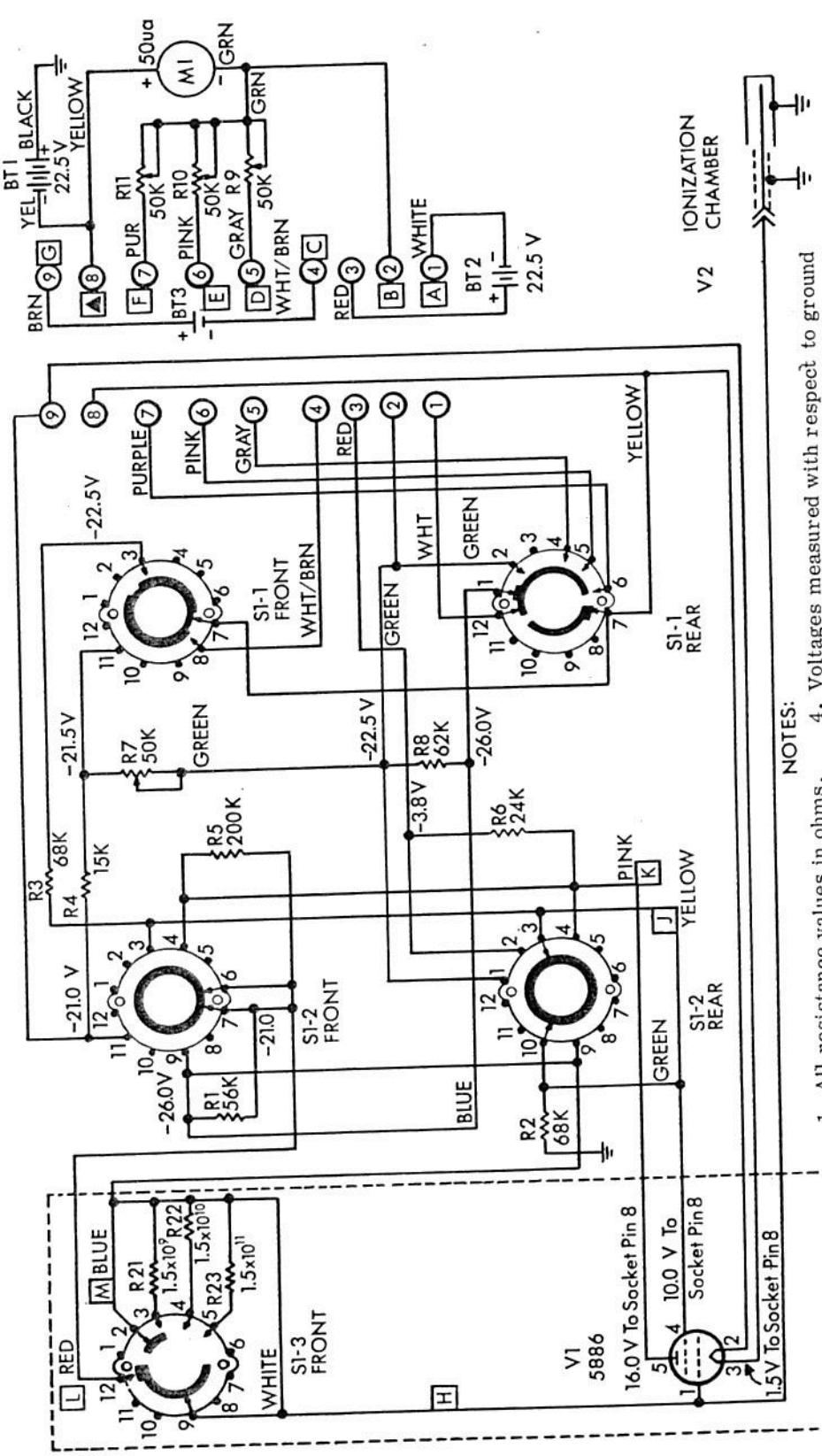


Figure 11-7. Schematic Circuit Diagram



NOTES:

1. All resistance values in ohms.
2. Switch in CHECK position.
3. [A] indicates Test Points.
4. Voltages measured with respect to ground with instrument correctly zeroed on ZERO range. Use a 20,000 ohms per volt meter.

Figure 11-8. Schematic Circuit Diagram Showing Switch Wafers and Socket Connections

PARTS LIST

Electrical Components

Circuit Symbol	Description	Function	Manufacturer	Mfrs. Part No.
BT1	Battery, hearing aid type 22-1/2V NEDA 215	High voltage supply for electrometer tube and ion chamber	Union Carbide	412
BT2	Battery, hearing aid type 22-1/2V NEDA 215	High voltage supply for electrometer tube and ion chamber	Union Carbide	412
BT3	Battery "D" size 1-1/2V NEDA 13	Electrometer tube filament power supply	Union Carbide	950
M1	Meter 0-50 ua	Visual indicator	Chatham Electronics, Inc.	10412
R1	Resistor 56K ±5% 1/2W	Voltage divider for circuit check	International Resistance Co.	BTS-20
R2	Resistor 68K ±10% 1/2W	Voltage divider for screen grid voltage	International Resistance Co.	BTS-20
R3	Resistor 68K ±10% 1/2W	Voltage divider for screen grid voltage	International Resistance Co.	BTS-20
R4	Resistor 15K ±10% 1/2W	Bucking current limiting resistor	International Resistance Co.	BTS-20
R5	Resistor 200K ±5% 1/2W	Voltage divider for circuit check	International Resistance Co.	BTS-20

Circuit Symbol	Description	Function	Manufacturer	Mfrs. Part No.
R6	Resistor 24K ±5% 1/2W	Plate load resistor	International Resistance Co.	BTS-20
R7	Potentiometer 50K 1/2W	Zero adjust	Clarostat Mfg. Co.	47-50K-S
R8	Resistor 62K ±5% 1/2W	Cathode resistor	International Resistance Co.	BTS-20
R9	Potentiometer 50K	Calibration control, X100	Chicago Telephone Supply Corp.	CTS-DF-2247 Type 70 (LT)
R10	Potentiometer 50K	Calibration control, X10	Chicago Telephone Supply Corp.	CTS-DF-2247 Type 70 (LT)
R11	Potentiometer 50K	Calibration control, X1	Chicago Telephone Supply Corp.	CTS-DF-2247 Type 70 (LT)
R21	Resistor 1.5×10^9 ohms ±10% (red)	Input resistor, X100	Victoreen Instrument Co.	———
R22	Resistor 1.5×10^{10} ohms ±10% (green)	Input resistor, X10	Victoreen Instrument Co.	———
R23	Resistor 1.5×10^{11} ohms ±10% (blue)	Input resistor, X1	Victoreen Instrument Co.	———

Circuit Symbol	Description	Function	Manufacturer	Mfrs. Part No.
S1-1	Switch section phenolic	Selector switch for power, range, zeroing and checking functions	Chatham Electronics, Inc.	10446-1
S1-2	Switch section, phenolic	Selector switch for power, range, zeroing and checking functions	Chatham Electronics, Inc.	10446-2
S1-3	Switch section, ceramic	Chamber load range switch section	Chatham Electronics,Inc.	10446-3
V1	Electrometer tube	Amplifier	Raytheon Mfg. Co.	5886
V2	Ionization chamber assembly	Radiation detector	Chatham Electronics,Inc.	10431

Mechanical Components

Description	Function	Manufacturer	Mfrs. Part No.
Battery mounting bracket assembly	Holds batteries	Chatham Electronics, Inc.	10442
Battery mounting bracket spacer (2)	Positions battery mounting bracket	Chatham Electronics, Inc.	10438
Beta shutter	Covers beta window	Chatham Electronics, Inc.	10425
Beta shutter detent	Positions beta shutter	Chatham Electronics, Inc.	10406
Boot	Water seal, zero control	Radio Frequency Labs.	H-1268
Capsule bottom	Holds high impedance components	Chatham Electronics, Inc.	10449
Capsule cover	Covers capsule	Chatham Electronics, Inc.	10471
Capsule gasket	Water seal	Chatham Electronics, Inc.	10472
Case	Instrument bottom cover	Chatham Electronics, Inc.	10439
Chamber gasket	Water seal	Precision Rubber Products Corp.	909-19-C-718-50
Chamber hole plug	Seal	Walter L. Schott Co.	7308
Chamber retainer	Holds chamber	Chatham Electronics, Inc.	10424
Circuit diagram	Schematic diagram in case bottom	Chatham Electronics, Inc.	10401

Description	Function	Manufacturer	Mfrs. Part No.
Cover	Instrument panel	Chatham Electronics, Inc.	10408
Cover gasket	Water seal	Chatham Electronics, Inc.	9
Handle	Carrying handle	Chatham Electronics, Inc.	10407
Instruction manual (2)	Operating instructions	Chatham Electronics, Inc.	119
Knob	Range switch knob	Gee Lar Mfg. Co.	910-SS
Knob	Zero control knob	Gee Lar Mfg. Co.	170-SS
Meter gasket	Water seal	Precision Rubber Products Corp.	914-48-C-750-70
Mounting screw	Holds case sections together	Chatham Electronics, Inc.	10441
Mounting screw gasket	Water seal	Precision Rubber Products Corp.	902-5-C-711-70
Spacer retainer (2)	———	Chatham Electronics, Inc.	10427
Strap assembly	Carrying strap	Chatham Electronics, Inc.	10534
Wire Assembly	Chamber cable	Chatham Electronics, Inc.	10444